Citation:

Tsuchiya A, Almiron-Roig E, Lluch A, Guyonnet D, Drewnowski A. Higher satiety ratings following yogurt consumption relative to fruit drink or dairy fruit drink. *J Am Diet Assoc.* 2006 Apr;106(4):550-7.

PubMed ID: 16567151

Study Design:

Randomized crossover trial

Class:

A - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine the impact of two yogurts and two isocaloric beverages on hunger, thirst, satiety and energy intakes at the next meal.

Inclusion Criteria:

- Normal body weight (BMI = 20 to 27 kg/m^2)
- Not following a diet to gain or lose weight
- Non-smoker
- Consumed breakfast regularly

Exclusion Criteria:

- Individuals with food allergies or food restrictions
- Those who disliked two or more foods or beverages used in the breakfasts and lunches
- Those on prescription medications likely to affect taste, smell or appetite
- Athletes in training
- Individuals reporting recent weight loss

Description of Study Protocol:

Recruitment: Participants aged 18 to 35 years were recruited at the University of Washington using advertisements and flyers. A telephone prescreen was used to determine eligibility.

Design: Randomized crossover trial

Blinding used: No - Participants and data collectors aware of preload consumed

Intervention: A preload stimuli was provided 90 minutes after a light breakfast and 90 minutes prior to lunch. The preloads were provided over a course of four sessions and consisted of a fruit beverage composed of peach syrup and water, a milk-based peach and apricot beverage, a semisolid peach yogurt containing peach pieces and the same yogurt homogenized to liquid form. All preloads were 200 kcal. The preloads were presented chilled but not on ice.

Participants rated hunger, thirst, nausea, fullness and desire to eat using 9-point category scales. The unipolar adjective scales were anchored at each end with labels "1=not at all" and "9=extremely". Participants rated each preload on a number of sensory attributes using 9-point category scales. They also rated their preference of each preload along 9-point hedonic preference scales in which "1=dislike extremely" and "9=like extremely".

Breakfast consisted of orange juice, toasted white bread and a butter blend, which provided 266 kcal, 4.4 g protein and 41.2 g carbohydrate and 9.2 g fat. Lunch was offered at noon. Each lunch provided 1488 kcal and included both savory and sweet foods. Participants were told that they could have as much or little of any food they wished. Noncarbonated water was the only beverage provided with the meal. All foods and water were weighed at the time of serving and plate waste was collected and weighed by experimenters. Additional preweighed portions were available from a self-service buffet and participants were asked to record any additional foods consumed including extra water.

Statistical Analysis:

- Analysis of variance - used to analyze motivational ratings, energy intakes, nutrient analyses, energy intake, water intake, weight of food, sensory profiles and hedonic ratings across beverages
- Smirnov-Kolmogorov test - used to test normality
- Pearson correlation - used to test the strength of association between variables.

Data Collection Summary:

Timing of Measurements: Potential candidates were asked to report to the lab for a brief session during which their height and weight were measured. Individuals who met the eligibility criteria were invited to participate and were given a reminder card stating the dates and times for the study sessions. Participants were asked to come to the laboratory after an overnight fast and on the same day of the week.

The four sessions lasted from 8:45 am to 12:30 pm and were spaced at least 1 week apart. A light breakfast was provided upon arrival at the laboratory. The preload was provided 90 minutes later and lunch was provided 90 minutes after that. Breakfast was served at 9 am to provide a stable baseline for hunger ratings.

Participants were seated in separate cubicles in the laboratory and remained there for the duration of the session and were allowed to read, listen to music with earphones or use their portable computers with the exception of Internet access to minimize visual cues which may have affected appetite.

Dependent Variables

- Hunger, thirst, satiety: 1 (not at all) -9 (extremely) scales
- energy intake at a meal following a snack: calculated using Food Processor software, from

weight consumed as well as additional foods consumed reported by subject

Independent Variables

- Preload condition: Yogurt (with peaches in semi-solid form and in a homogenized form) and isocaloric beverage (peach syrup and water; milk-based peach and apricot beverage)

Control Variables

- Weight, intake prior to the study (participants arrived after fasting)

Description of Actual Data Sample:

Initial N: 32 participants (16 men and 16 women)

Attrition (final N): 32 participants

Age: 18-35 years old

Mean age (± standard deviation) was:

- 28.5±3.9 years for men
- 25.7±5.1 years for women
- 27.1±4.7 years for the whole group

Ethnicity: Not noted

Other relevant demographics: Participants were from the University of Washington

Anthropometrics: . Mean BMI (kg/m^2) (± standard deviation) was

- 23.5±1.6 for men
- 22.3±2.0 for women
- 22.9±1.9 for the whole group.

Location: University of Washington

Summary of Results:

Key Findings

- The four isocaloric preloads had different effects on hunger and fullness. Hunger ratings varied by preload; the main effect of condition [$F_{(3,90)}=3.64$, $P<0.05$] was significant
- The desire to eat was also differentially affected by the four preloads [$F_{(3,90)}=2.96$, $P<0.05$]
- The yogurts tended to be more satiating than the fruit drink or the dairy drink although the effects were weak ($P>0.05$)
- Yogurts led to the highest fullness ratings [$F_{(3,90)}=5.18$, $P<0.005$]
- Multiple pairwise comparisons showed that the two yogurts led to higher fullness than the dairy fruit drink ($P<0.05$). No main effect of sex [$F_{(1,30)}=2.75$, $P<0.05$] was observed
- The fruit drink suppressed thirst more than did either of the two yogurts, as evidenced by the main effect of condition [$F_{(3,90)}=4.82$, $P<0.005$] and Bonferroni-corrected tests ($P<0.05$)
- When the two yogurts (liquid and semisolid) and the two beverages (juice- and milk-based) were analyzed using a nested analysis of variance for repeated measures the yogurt condition was associated with lower ratings of hunger and desire to eat and higher ratings for fullness

relative to the beverage condition [$F_{(1,30)}$=13.9 for fullness; $F_{(1,30)}$=9.79 for hunger; $F_{(1,30)}$=8.13 for desire to eat; P<0.01]

- In contrast, the two beverages (fruit drink and dairy fruit drink) were associated with lower ratings of thirst [$F_{(1,30)}$=10.2, P<0.005]
- Mean energy intake (± standard error of the mean) across the 4 conditions was 806±43 kcal
- There were no sex differences in energy intakes at lunch and so the data were pooled for all 32 participants
- When the yogurts were compared to the two beverages, energy intakes at lunch were lower (790±46 kcal for yogurts vs 823±50 kcal for beverages); however, that effect failed to reach significance [$F_{(1,30)}$=3.18, P0.084]
- Nutrient composition of the test meal was unaffected by preload type (P>0.05 for all conditions)
- The composition of the lunch meal, as consumed, was 50% of energy from carbohydrate (including 18.4% from sugar), 13.5% from protein and 36.8% from fat
- Hunger ratings and the desire to eat immediately preceding lunch (time 9) were not a reliable predictor of subsequent energy intakes (P>0.05 for both tests). In contrast, thirst ratings did correlate with water consumption at lunch (r=0.47, P<0.001). Water intakes at lunch were significantly higher following the two yogurts [$F_{(1,30)}$=15.01, P<0.005].

Mean energy intakes (breakfast, snack and lunch), mean water consumption (lunch) and mean weight of foods consumed (lunch) for each of the four beverage conditions in a study to compare the satiating power of semisolid and liquid yogurts with fruit beverages and dairy fruit drinks (n=32)

Preload condition	Energy at lunch (kcal)	Energy at lunch + preload (kcal)	Energy at lunch + preload + breakfast (kcal)
Fruit drink	825±54	1025±54	1291±54
Dairy fruit drink	821±50	1022±50	1288±50
Liquid yogurt	803±53	1003±53	1268±53
Semisolid yogurt	776±50	977±50	1243±50
Drinks	823±50	1023±50	1290±50
Yogurt	790±46	990±46	1256±46

Other Findings:

- Mean hedonic ratings, measured along a 9-point scale, were: peach drink, 6.4±0.3; dairy fruit drink 6.6±0.3; liquid yogurt 5.6±0.3 and set yogurt 6.4±0.3. There were no significant differences in preference ratings by sex or across conditions
- Men reported higher ratings of hunger than did women [$F_{(1,30)}$=12.09, P<0.05]
- Desire to eat was higher in men then in women [$F_{(1,30)}$=9.26, P<0.01]

Author Conclusion:

- The two yogurts seemed to be more satiating that the two beverages as evidenced by temporal profiles of hunger and fullness and the reported desire to eat. However, the small differences in the satiating power of yogurts relative to beverages did not lead to a downward adjustment in energy intakes at lunch 90 minutes later
- The yogurts contained more protein (34% energy) than either the dairy fruit drink (5%) or the fruit drink (0%); whereas, the two beverages derived most of their energy from sugar (juice beverages 100%; milk containing beverage 93%)
- Differences in viscosity could also explain the yogurt effects. However, the semisolid yogurt, eaten with a spoon, was no different in satiating power from the drinkable liquid yogurt in the present study
- With an energy density of 0.48 and 0.53 kcal/g, both fruit/dairy drinks and fruit yogurts are classed as low-energy-density products; however, only the yogurts with the additional protein component present in significant amounts are able to exert a satiety effect
- The satiating power of yogurts may facilitate adherence to a low-calorie eating plan
- The consumption of yogurts led to an increased water consumption at lunch
- The palatable free lunch may have stimulated consumption, regardless of reported desire to eat
- In this study, low-fat yogurts, whether drinkable or eaten with a spoon, had a greater satiating effect than isocaloric fruit-based beverages or dairy fruit drinks. However, lower hunger and higher fullness ratings in this study did not lead to a downward adjustment in energy intakes at the next meal. The role of yogurt in weight management may involve not only calcium content but also its impact on hunger and satiety.

Reviewer Comments:

- *Small sample size*
- *This study only showed short-term impact of having snack between meals.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes

2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	???
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A

3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	No
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes

6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	Yes
6.6.	Were extra or unplanned treatments described?	Yes
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes

9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	???
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	???